TITLE: "Process and apparatus for feeding powdered, granular or herb-based products"

DESCRIPTION

The invention relates to any automatic machine operating on either a continuous or an alternating principle and provided with stations for dosing powdered, granular or herb-based products, or other bulk products; for example, it relates to compressing machines for producing tablets, capsule filling machines for packaging doses of the said products in hard gelatin capsules, and also machines in general for packaging the said products in bottles, filter bags, packets or other containers, for example machines for packaging tea or other infusions.

The aforesaid machines have in common the problem of feeding to their dosing stations the bulk product placed in a loose state in a hopper which, in machines having a carousel, is aligned with the axis of rotation of the said carousel and rotates jointly with the latter and with the dosing stations distributed outside the said hopper, in such a way that the said product flows in a continuous and uniform way to these dosing stations as a result of gravity and as a result of the centrifugal force generated by the rotation of the machine. Examples of machines of this type, devised by the present applicant, are described in US Patent 4,943,227 (Compressing machine for making tablets) of 24/7/1990, and in PCT Patent Application PCT/IB00/00341 of 22/03/2000 (Capsule filling machine to pack powder, herbs, microgranules, pellets). The solution of feeding the product by centrifugal force does not yield results which are constant over time, since the carousel machines do not always rotate at constant velocity, and because the centrifugal force impelling the product towards the dosing stations varies according to the quantity of product present in the feed hopper and as a function of the flowability of the said product and the surfaces on which it flows, these surfaces initially being clean and glossy but tending to become progressively dirtier and to increase their contact resistance and thus slow down the flow of the product. This solution of feeding the product by centrifugal force is not applicable in alternating machines, in which the product magazine is stationary, and it is therefore impossible to use these machines

to conduct reliable tests of the suitability for processing of the products used in continuous machines.

In other machines, whether continuous or alternating, there is a known way of applying suction to the peripheral part of the product hopper and/or directly to the dosing stations. This solution is rather difficult to implement, is not easily controlled, and does not work well with poorly flowing products such as herb-based products.

The invention is designed to overcome these and other drawbacks of the known art with the following idea for a solution. The product hopper is designed so that it can be sealed with respect to means for cyclic restocking with the said product and with respect to the external environment, and is designed so that it can be pressurized with compressed gas, in such a way that the said product is fluidized by the compressed gas and is pushed by the latter in a continuous and uniform way towards the peripheral dosing stations, which are designed to promote the flow of the product towards them. The hopper can also be designed to contain small quantities of product, since the feed characteristics remain constant until the whole of the said product has been used up. Clearly, this method also makes it possible to produce alternating test machines, in which the product to be dosed can be treated by feeding it in the same conditions as those found in continuous machines.

Further details of the invention, and the advantages derived therefrom, will be made clearer by the following description of a preferred embodiment of the invention, illustrated purely by way of example, and without restrictive intent, in the figures on the attached sheets of drawings, in which:

- Fig. 1 shows schematically, in lateral elevation and with parts shown in section, a product hopper connected to a dosing station for the said product;
- Fig. 2 shows schematically, in lateral elevation and with parts shown in section, the apparatus which provides continuity of operation of the hopper which feeds the product to the dosing stations, even when the product is loaded into the said magazine in a cyclical way;
- Fig. 3 shows a lateral view, with parts shown in section, of an industrial application of the solution shown in Figure 2.

In Figure 1, the number 1 indicates the hopper which contains the product P in a loose state, and which can be fixed, if it is to be used in an intermittent or alternating machine, or can be rotatable about its own vertical axis, if it is to be used in a carousel machine, in which the said hopper is fixed on the rotating turret T of the machine in a coaxial configuration. In the latter case, the upper part of the hopper is connected by means of a rotary joint 2 to a channel 3 running from means 13 of cyclically supplying the product P, this channel being fixed to any support structure 4 and being intercepted by an on/off valve 5 of any suitable type. The portion of the channel 3 between the valve 5 and the joint 2 is connected to a branch channel 6 which in turn is designed for connection to a source 7 for the delivery of gas at an appropriate pressure, according to the characteristics of the product to be treated and the dimensions of the apparatus. The gas for pressurizing the hopper 1 is preferably of the inert type.

The hopper 1 preferably has its base 101 raised towards the centre and is provided on the perimeter of the said base with a plurality of apertures 8 which are suitably spaced apart, and to which are connected, directly or by means of channels 108, dosing stations D, of the volumetric type for example, designed to form doses of the product P, for forming tablets C for example, or for packaging the said doses of product in gelatin capsules G, in bottles F, in filter bags or sachets S, or in packets B or other containers. It should be understood that the channels 108 can have any lengths, which can be different, and can be orientated or arranged in different ways from that shown. As a result of the specified and constant levels of pneumatic pressure created inside the hopper 1 by its connection to the source 7, the product P is obliged to flow towards the dosing chambers of the stations D and to form constant and repeatable doses therein, even if there is a progressive variation of the quantity of product present in the said hopper, and even if there are variations in the rotation speed of the said hopper and/or variations in other parameters, such as the flowability of the product or the walls of the circuit through which it passes. For their part, the volumetric dosing stations D are designed to facilitate the flow of the product towards them, for example by having a small vent 9 of controlled size and/or by

having suction means 10. The vent 9 is preferably such that it discharges downwards, in such a way that the small quantity of product that passes out of the said vent can easily be removed by suitable means. The volumetric dosing station D, as described in US Patent 4,943,227 for example, has a chamber with opposing punches, which initially leave free a specified volume of the said chamber, which is filled with the specified quantity of product, after which the punches are moved axially to reduce the said volume and to discharge the dosed product in a downward direction. When the product has been expelled, the punches can, for example, be designed to abruptly increase the volume of the dosing chamber, to create in the chamber a cavitation effect which facilitates the flow of the product thereto. The detailed operation of the dosing stations D will not be discussed here, since the said stations can be of any more or less well known type.

The gas for the internal pressurization of the hopper 1 also serves to fluidize the product towards the dosing stations D. However, it should be understood that specific means can be provided in the said hopper and/or in the channels 108 for fluidizing the product, provided that the product can withstand the action of these fluidizing means. In Figure 1, for example, the centre of the base 101 of the hopper 1 is shown as having a shaft 11 passing through it rotatably and with a seal, this shaft being made to rotate by suitable means with a small relative motion with respect to the hopper 1, and carrying on its upper end one or more blades 12 which for example terminate at a short distance from the perimetric apertures 8 of the said hopper, in such a way as to improve the fluidity of the product towards these discharge apertures and consequently towards the dosing stations D.

It should be understood that, as an alternative to or in combination with the pressurization of the hopper 1 from above, the said hopper can be pressurized from below, for example through the hollow shaft 11 and possibly through holes made in the blades 12 which are also hollow.

With reference to Figure 2, a description will now be given of the apparatus which carries out the cyclical re-supply of product to the hopper 1, thus ensuring the continuous pressurized operation of the hopper.

The hopper 1 is preferably of conical shape and converges towards its top, in such a way as to promote the flow of the product towards the perimeter of its base and also in order to facilitate the internal washing and sterilization cycle.

The inlet of the valve 5 is connected to the outlet aperture of a compensation chamber 13 having a suitable volume for containing a batch of product to be fed cyclically to the hopper 1, this chamber being located above the hopper 1 and its upper inlet aperture 113 being intercepted by an on/off valve 14, which connects this aperture to the product feed means 15. These means can, for example, comprise a further chamber 15 whose capacity is at least equal to that of 13, provided with means 16 for detecting the level of product therein and connected to means 17 of feeding the said product. The chamber 15 always operates at atmospheric pressure and is used for preparing the batch of product to be transferred to the compensation chamber 13, which is at atmospheric pressure when it receives the product from the preparation chamber 15, but which is pressurized for the transfer of the batch to the hopper 1. For the last-mentioned purpose, the upper part of the compensation chamber 13 is connected to a channel 18 which branches into a plurality of channels, two of which are intercepted by on/off valves 19 and 20, while the third is connected to an instrument 21 which detects the internal pressure of the chamber 13. The valve 19 controls the connection of the channel 18 to a source 107 for the delivery of compressed gas, while the valve 20 controls the connection of the said channel 18 to the exterior via a filter 22 and/or other suitable means of recovery the residues of product which may flow out of the chamber 13 in the course of depressurization (see below).

The apparatus is completed by an instrument 121 which detects the pressure within the hopper 1, and sensors 23 and 24 which detect the minimum and maximum levels of product within the said hopper 1. All the described parts are controlled by a processor 25 connected to a programming and interrogation unit 26. The apparatus operates in the following way. A batch of product is prepared in the chamber 15, and the feed means 17 are automatically stopped when the sensor 16 signals that the specified level has been reached in this chamber. The valves 5, 14 and 19 are

closed, while the valve 20 is opened to bring the chamber 13 to atmospheric pressure. When this condition is reached, the valve 14 is opened, and the batch of product passes by gravity from the preparation chamber 15 to the underlying chamber 13, after which the valves 14 and 20 are closed and the preparation cycle for a new batch of product commences in the chamber 15. In the next step, the valve 19 is opened and the compensation 13 is brought to an internal pressure equal or slightly greater than the internal pressure of the hopper 1, and when this condition is reached and when the re-supply activation signal is received from the said hopper, the valve 5 is opened, so that the batch of product passes from the chamber 13 to the hopper 1 by gravity, and, if necessary, as a result of the small and momentary pressure difference between 13 and 1. When the batch of product has been transferred, and while the hopper 1 continues to operate under pressure, the valve 5 is closed, and the whole apparatus is set for the execution of a new operating cycle as described.

The operating program of the processor 25 also includes a step in which the valves 5 and 14 are opened simultaneously at the point when cleaning fluids are to be passed through the whole of the apparatus to prepare it for the processing of different products.

Figure 3 shows a possible embodiment on an industrial scale of the apparatus as shown in Figure 2. The hopper 1 is formed from a lower bowl 201, with perimetric product outlet apertures 8 and with a shaft 11 passing rotatably and with a seal through its base 101, the said bowl being sealed by a conical cover 301 whose upper edge interacts and forms a seal with the joint 2 fixed to the lower flange 3 of the compensation chamber 13, of cylindrical shape for example, which is fixed to the supporting frame 4 and has its lower outlet closed by the valve 5 consisting of a conical plug which opens by moving into the hopper 1, so that it is kept closed by the pressure which is constantly present in the said hopper. The upper end of the chamber 13 is provided with a flange 213 to which is fixed with a seal the lower flange 115 of the preparation chamber 15, also of cylindrical shape and with a round cross section, which is closed at its top by a cover 215 and has a tapered lower outlet

connected to the compensation chamber 13 and closed by a conical plug 14 which opens by moving into the said chamber 13 in such a way that it is kept closed by the said pressure that is present cyclically in this chamber 13. The plug 14 is integral with the rod 114 of a double-acting cylinder and piston unit 214 whose casing is fixed to that of a cylinder and piston unit 205, also double-acting, which is placed above the unit 214 and whose rod 105 passes axially and with a lateral seal through the plug 14 and the aforesaid rod 114 and is integral with the plug 5. The assembly consisting of the casings of the cylinder and piston units 205 and 214, which preferably terminates in a conical and upwardly converging upper end, is positioned coaxially in the preparation chamber 15 and is kept suspended therein by a suitable number of suitably staggered spokes 305 and 314, some of which are axially hollow so that they can also be used as channels for the injection and discharge of the fluid into and from the opposing pressure chambers of the said units 205 and 214, these channels being connected externally to switch valves 405 and 414 controlled by the processor 25 and connected to the pressure interface 70, which, for example, provides the aforesaid power supplies 7 and 107 to the hopper 1 and to the compensation chamber 13. It is to be understood that the assembly consisting of the casings of the units 205 and 214 can, if necessary, be integral with the cover 215.

The preparation chamber 15, closed at its lower end by the plug 14, is cyclically connected to the feed source of the product, which can, for example, be fed by gravity or by suction. In the latter case, the chamber 15 is used as a settling cyclone, being provided with a hole in its cover 215 connected to a suction means 17 with a filter 117 on the outlet channel. The chamber 15 is also provided, in a central or upper area, with a tangential hole to which is attached a channel 315 connected to the product feed source. When the suction means 17 is activated, a vacuum is created in the chamber 15 and draws the product from the channel 315, and when the product arrives in the chamber 15 it falls downwards and accumulates in the chamber until it reaches the level detected by the indicator 16. The operation of the apparatus is identical to that described with reference to the diagram in Figure 2. Clearly, the plugs 5 and 14 can be operated with small alternating axial movements

before closing, to promote the complete transfer of the product from the upstream to the downstream chamber. Clearly, also, the said plugs can be opened and closed with a minimum of force by the corresponding pneumatic actuators, since the opposing faces of the said plugs are in environments at equal pressure. Furthermore, as stated previously, the plugs are pushed into the closed position by the pressure of the chambers below them, and therefore the actuators 205 and 214 do not have to exert any significant force.

Clearly, the whole of the apparatus shown in Figure 3 is designed to permit complete and uniform cleaning with washing and sterilizing fluids which can be made to circulate in it on command.

It should be understood that the description does not include the details of construction of the valves 405, 414, 19 and 20, since these means can easily be produced by persons skilled in the art.